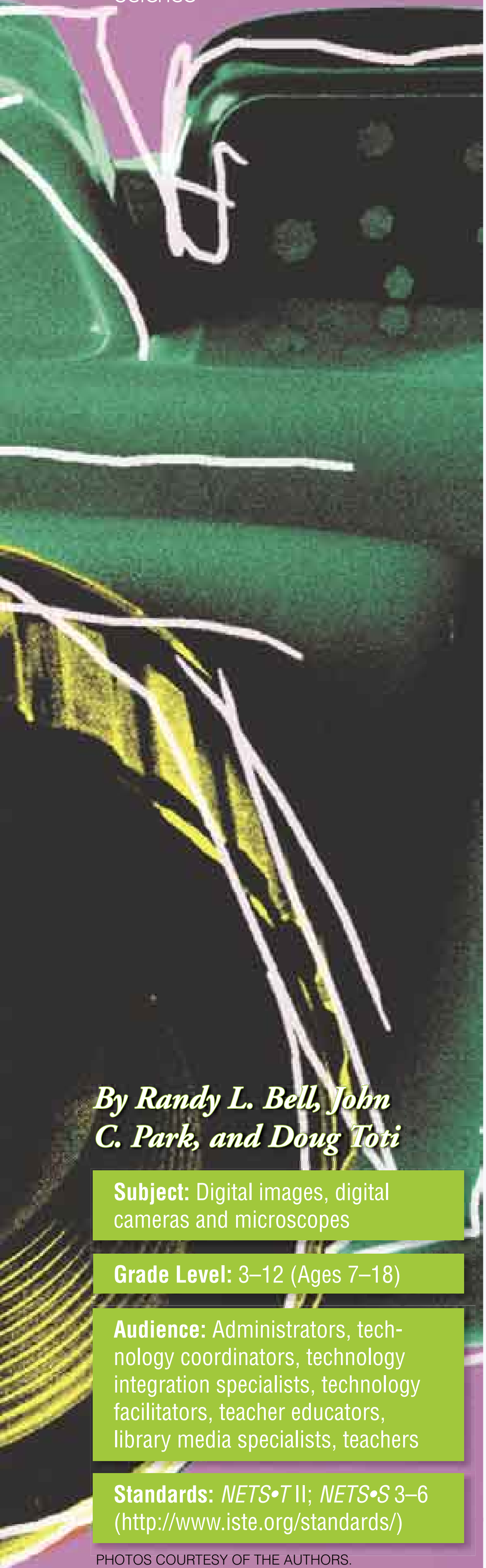

Digital Images in the Science Classroom

By Randy L. Bell, John C. Park, and Doug Toti

Subject: Digital images, digital cameras and microscopes

Grade Level: 3–12 (Ages 7–18)

Audience: Administrators, technology coordinators, technology integration specialists, technology facilitators, teacher educators, library media specialists, teachers

Standards: *NETS•T* II; *NETS•S* 3–6 (http://www.iste.org/standards/)

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In many ways, the role of visualization in science is distinct from other disciplines. Many natural processes—and even some objects—are too small, too fast, too slow, or too far away to view without highly specialized equipment.

Of course, students at every grade level can understand a phenomenon better when they can see it. That is why textbooks attempt to illustrate scientific concepts with photographs and diagrams, and science teachers stock their classrooms with microscopes. Teachers have also taken advantage of videotapes and laserdiscs to present a wider variety of visual images to students. The World Wide Web opened access to even more up-to-the-minute, state-of-the-art scientific images. In all these examples, however, the control of the content remains solely with the teacher.

The new generation of imaging sensors (such as charge coupled displays, or CCDs) have made digital cameras and other technologies possible that can put the control of image making in the hands of students.

Acquire

Scientific images of natural phenomena can be captured during a walk through the neighborhood or on a vacation trip. The ubiquitous presence of digital cameras generates thousands of images every day. These images can often be mined for exploration of scientific concepts. The image shown in Figure 1 is an example of this. While he was attending a professional conference in central Florida, one of the authors (John Park) discovered serendipitously that a launch of the space shuttle would take place during his visit. Because he travels with a compact digital camera, it was possible to capture the event without any additional specialized equipment.

John captured two dozen images of the launch of the space shuttle *Discovery* from NASA's observation deck in Titusville, Florida, approximately 13 miles from its lift-off from Launch Pad B.

The pictures John took were intended as a record of the trip rather than for instructional purposes, but a subsequent review of the pictures revealed a number of scientific concepts embedded in the images. These images led to development of an instructional activity now employed in science education courses at both North Carolina State University and the University of Virginia.

Microscopes, one of the most common hands-on tools used in the science classroom, are another example of instructional uses of digital images. Conventional microscopes have several limitations as instructional tools. Some students have trouble focusing microscopes and there is no easy way for a teacher to check their focusing skills. Others mistake key features

Figure 1. March 8, 2001, Launch of Space Shuttle *Discovery*.

of specimens viewed under the microscope. Consequently, much of a teacher's available instructional time is spent trying to ensure that students are seeing what they should be seeing. In addition, students have no way of capturing and sharing what they see.

Digital cameras and microscopes allow students to project images on a computer monitor or movie screen and highlight features or phenomena of interest. Students can capture still or moving images for later analysis (see Figure 2 for examples).

Many digital cameras can be directly connected to existing school microscopes. As long as the camera is threaded for interchangeable lenses, it can be fitted with an adapter to attach it to a microscope (Figure 3). Firms such as Scopetronix provide adapters for many different makes and models of digital cameras. (For this and other useful URLs, see the Resources section on p. 28.) This approach to acquisition of images allows schools to build on and extend existing resources.

In addition to retrofitting existing microscopes, teachers and students have access to digital microscopes designed specifically for this purpose. The Intel QX-3 was one of the first such digital microscopes to be used extensively in science classes. One advantage of this new genre of tools is that they can be both affordable and easy to use. The Intel QX-3 was so easy to use that it was originally designed and marketed as a toy. Although Intel eventually stopped producing the QX-3, firms such as Neo/Sci and Digital Blue have adapted and remarketed it with guides that provide curriculum activities linked to science education standards.

A number of digital microscopes and cameras include time-lapse capabilities that can be useful both when coupled to a microscope and when directly used for data collection. Images captured through time-lapse photography and stored in digital format can be played back in the form of a digital movie. Students can then repeatedly watch the process as it occurs in faster-than-real time, but stop it at any point to make observations or measurements.

Time-lapse capabilities make it possible to capture a flower opening, a butterfly emerging from a chrysalis, or parasitic wasps emerging from a tomato hornworm larvae. When science students can acquire and analyze images of this kind, they can gain ownership and a deeper understanding of scientific processes.

Analyze

The images of the space shuttle launch demonstrate that science concepts are everywhere if you closely examine and interpret what is seen. One advantage of digital cameras is that many images can be captured rapidly and stored on compact media. By shooting many images at various angles, exposures, and lens adjustments, there is a high probability that a few of the pictures will include interesting science!

Examining Figure 4 leads us to ask a number of questions:

- Why is there a color difference in the sky just above the horizon in comparison with the sky at the top of the image?
- The exhaust plume near the horizon is a dark red, whereas the plume at higher altitudes appears to be white. What would cause this?
- Are the winds at the ground surface moving at the same speed as at higher altitudes?

Analyzing digital images can also help students overcome misconceptions. For example, many students have difficulty recognizing that plants, like animals, are alive, because plants do not move in the manner of other living organisms. Time-lapse video of plant growth, such as a seed sprouting or a vine twining itself around a branch, can make the abstract concept of plant movement directly observable and more concrete.

In one example of an inductive, hands-on activity, students develop understanding of the role of cooling time in the development of crystals by capturing time-lapse images of drops of saltwater evaporating at different rates. Figure 5 displays a series of images captured as a drop of salt water

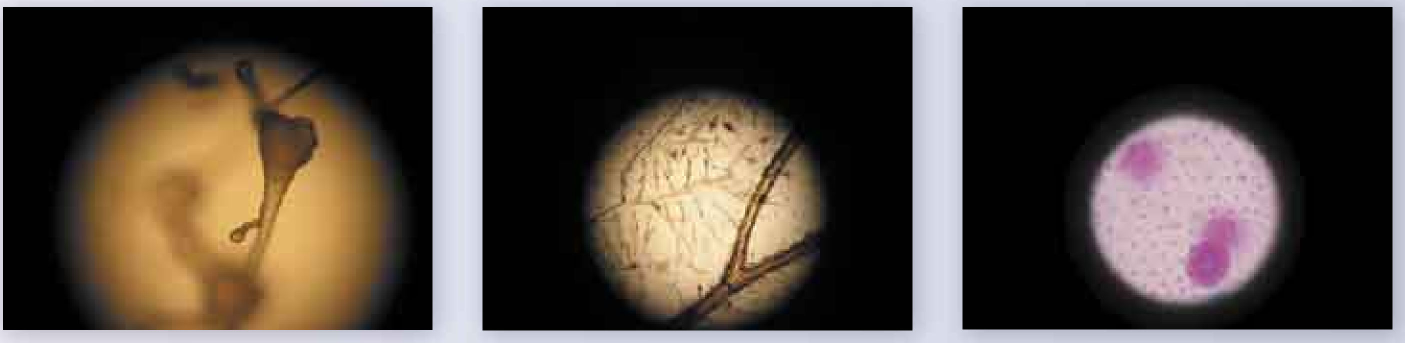

Figure 2. Images captured with a digital camera and compound microscope. (From left to right: slime mold (100x), bee wing (100x), and the microscopic organism volvox (100x).

Figure 3. A Canon PowerShot A-60 digital camera attached to a compound microscope.

Figure 4. This shot was taken minutes after the shuttle launch using default camera settings.

evaporated at room temperature. Salt crystals form in a ring at the periphery of the drop of water. These images can be compared to those of a drop for which evaporation was accelerated, and students can begin making inferences and drawing conclusions about their results (Figure 6).

Create

Contrary to what many students believe, the scientific endeavor involves a great deal of intuition and creativity, especially at the point of synthesizing data and drawing conclusions from it. For example, as students try to make sense of the digital data in Figures 5 and 6, they will find that they must rely heavily on their inferencing skills, intuition, and knowledge of scientific principles to create acceptable explanations for why crystal sizes differ, why the crystals form in a ring, and so on. Students use knowledge gained from their observation and analysis of digital images to create new explanations that can solidify their understandings of scientific principles.

The Butterfly Project developed by preservice teacher Anne Bowen and profiled in the March 2004 issue of *L&L* (pp. 24–27) is an excellent example of creativity engendered by digital photography use in a biology class. Rather than having her students spend 15 minutes reading about the butterfly life cycle from a textbook, students observed real butterflies over the course of their life cycle, capturing the metamorphosis with digital cameras and microscopes. Students had many opportunities to create ways to best capture life cycle events and figure out why and what was happening. This was very much a student-driven activity, in which students' creativity, intuition, and scientific knowledge were used to drive technology-aided exploration of a natural process.

Communicate

The scientific process consists not only of discovery but also of communication of findings through scientific publication. The description of the effects of crystal formation can be recorded in a table in a science report.

When the images are in digital form, they can also be included in the report. Most word processors now include annotation features that also allow images and graphics to be labeled. Students increasingly maintain electronic portfolios of their work. When an electronic portfolio is posted on the Web, it allows parents to easily view and follow their children's work. This also facilitates inclusion of multimedia elements, such as a video clip of a butterfly emerging from a chrysalis or digital movies of saltwater evaporating.

Figure 6. Effects of fast and slow evaporation on crystal formation in saltwater.

Figure 5. Time-lapse sequence showing crystal formation as a drop of salt water evaporates.

Conclusions

Digital images offer a means of extending and building upon traditional methods of inquiry in science class. The role of the student can shift from passive observer to engaged participant. Benefits include the ability to capture events that would not otherwise be observable, and to share conclusions about such events through images incorporated into science journals and Web sites.

Resources

Digital Blue: http://playdigitalblue.com/products/qx3/info/
Neo/Sci: http://www.neosci.com
Scopetronix: http://www.scopetronix.com

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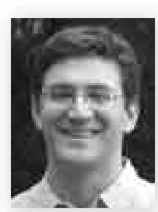

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